

What is claimed is:

1. A substrate support useful in a reaction chamber of a plasma processing apparatus, the substrate support comprising:
 - a ceramic member;
 - a metallic heat transfer member overlying the ceramic member, the heat transfer member having a maximum thickness of about $\frac{1}{4}$ inch, the heat transfer member including at least one flow passage through which a liquid can be circulated to heat and/or cool the heat transfer member; and
 - an electrostatic chuck overlying the heat transfer member, the electrostatic chuck having a support surface for supporting a substrate in a reaction chamber of a plasma processing apparatus.
2. The substrate support of Claim 1, wherein the heat transfer member has a maximum thickness of about $\frac{1}{8}$ inch.
3. The substrate support of Claim 1, wherein the at least one flow passage has a width of about $\frac{1}{32}$ to about $\frac{3}{32}$ inch, and a depth of about $\frac{1}{32}$ to about $\frac{1}{16}$ inch.
4. The substrate support of Claim 1, further comprising a source of temperature controlled liquid in flow communication with the at least one flow passage.
5. The substrate support of Claim 4, wherein the source of temperature controlled liquid includes a Peltier cooler operable to change the temperature of the liquid to a selected temperature.

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6. The substrate support of Claim 4, further comprising:

a heat transfer gas source operable to supply a heat transfer gas between the support surface and the substrate; and

a controller operable to (i) control the volumetric flow rate and/or the temperature of the liquid circulated through the at least one flow passage, and/or (ii) to control the flow rate and/or pressure of the heat transfer gas supplied between the support surface and the substrate.

7. The substrate support of Claim 1, wherein the heat transfer member comprises a base including the at least one flow passage, and a cover overlying the base.

8. The substrate support of Claim 1, wherein:

the ceramic member includes a recessed surface and a peripheral flange, the ceramic member has a thickness of from about 1-4 mm at the recessed surface;

the heat transfer member is disposed on the recessed surface and laterally spaced from the flange; and

the electrostatic chuck contacts the flange.

9. The substrate support of Claim 1, further comprising a ceramic ring overlying the ceramic member and surrounding the heat transfer member and the electrostatic chuck, the heat transfer member being laterally spaced from the ceramic ring, the electrostatic chuck contacting the ceramic ring.

10. The substrate support of Claim 1, further comprising an RF power source electrically connected to the heat transfer member.

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11. The substrate support of Claim 1, further comprising an elastomeric joint between the ceramic member and the heat transfer member, and an elastomeric joint between the heat transfer member and the electrostatic chuck.

12. A plasma processing apparatus comprising the substrate support of Claim 1.

13. A method of thermally controlling a substrate in a plasma processing apparatus, comprising:

placing a substrate on the support surface of the substrate support according to Claim 1 in a reaction chamber of a plasma processing apparatus;
introducing a process gas into the reaction chamber;
generating a plasma from the process gas in the reaction chamber;
processing the substrate; and
circulating a liquid through the at least one flow passage to control the temperature of the heat transfer member to a selected temperature during processing of the substrate.

14. The method of Claim 13, further comprising:

circulating a liquid having a first temperature through the at least one flow passage to control the temperature of the heat transfer member to a first temperature during processing of the substrate; and
circulating a liquid having a second temperature through the at least one flow passage to control the temperature of the heat transfer member to a second temperature during processing of the substrate;

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wherein the temperature of the heat transfer member is (i) ramped from the first temperature to the second temperature, or (ii) changed step-wise from the first temperature to the second temperature.

15. A substrate support useful in a plasma processing apparatus, comprising:

a source of temperature controlled liquid;

a ceramic member;

a metallic heat transfer member overlying the ceramic member, the heat transfer member including at least one flow passage in fluid communication with the liquid source and through which the liquid can be circulated to heat and/or cool the heat transfer member at a rate of from about 0.25-2 °C/sec; and

an electrostatic chuck overlying the heat transfer member, the electrostatic chuck having a support surface for supporting a substrate in a reaction chamber of a plasma processing apparatus.

16. The substrate support of Claim 15, wherein the heat transfer member has a maximum thickness of about 1/8 inch.

17. The substrate support of Claim 15, further comprising:

a heat transfer gas source operable to supply a heat transfer gas between the support surface and the substrate; and

a controller operable to control operation of the liquid source and the heat transfer gas source.

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18. The substrate support of Claim 15, wherein the heat transfer member comprises a base including at least one flow passage, and a cover overlying the base.
19. The substrate support of Claim 15, wherein the ceramic member includes a recessed surface and a peripheral flange, the heat transfer member is disposed on the recessed surface and laterally spaced from the flange, and the electrostatic chuck contacts the flange.
20. The substrate support of Claim 15, further comprising a ceramic ring overlying the ceramic member and surrounding the heat transfer member and the electrostatic chuck, the heat transfer member being laterally spaced from the ceramic ring, the electrostatic chuck contacting the ceramic ring.
21. The substrate support of Claim 15, further comprising an RF power source electrically connected to the heat transfer member.
22. The substrate support of Claim 15, further comprising an elastomeric joint between the ceramic member and the heat transfer member, and an elastomeric joint between the heat transfer member and the electrostatic chuck.
23. A plasma processing apparatus comprising the substrate support of Claim 15.
24. A method of thermally controlling a substrate in a plasma processing apparatus, comprising:

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placing a substrate on the support surface of the substrate support according to Claim 15 in a reaction chamber of a plasma processing apparatus;
introducing a process gas into the reaction chamber;
generating a plasma from the process gas in the reaction chamber;
processing the substrate; and
circulating the liquid from the liquid source through the at least one flow passage to control the temperature of the heat transfer member to a selected temperature during processing of the substrate.

25. The method of Claim 24, further comprising:
circulating a liquid having a first temperature through the at least one flow passage to control the temperature of the heat transfer member to a first temperature during processing of the substrate; and
circulating a liquid having a second temperature through the at least one flow passage to control the temperature of the heat transfer member to a second temperature during processing of the substrate;
wherein the temperature of the heat transfer member is (i) ramped from the first temperature to the second temperature, or (ii) changed step-wise from the first temperature to the second temperature.

26. A method of processing a substrate in a plasma processing apparatus, comprising:
supporting a substrate on a support surface of an electrostatic chuck in a reaction chamber of a plasma processing apparatus;
plasma processing the substrate; and
circulating a liquid through at least one flow passage extending through a metallic heat transfer member underlying the electrostatic chuck so as to control

the temperature of the substrate, the heat transfer member having a maximum thickness of about $\frac{1}{4}$ inch.

27. The method of Claim 26, wherein the heat transfer member has a maximum thickness of about $\frac{1}{8}$ inch, and the at least one flow passage has a width of about $\frac{1}{32}$ to $\frac{3}{32}$ inch, and a depth of about $\frac{1}{32}$ to $\frac{1}{16}$ inch.

28. The method of Claim 26, further comprising supplying a heat transfer gas between the support surface and the substrate during plasma processing of the substrate.

29. The method of Claim 26, further comprising applying RF power to the heat transfer member.

30. The method of Claim 26, wherein the heat transfer member is heated and/or cooled by the liquid at a rate of from about $0.25\text{-}2^{\circ}\text{C/sec.}$

31. The method of Claim 26, further comprising:
circulating a liquid having a first temperature through the at least one flow passage to control the temperature of the heat transfer member to a first temperature during processing of the substrate; and
circulating a liquid having a second temperature through the at least one flow passage to control the temperature of the heat transfer member to a second temperature during processing of the substrate;

wherein the temperature of the heat transfer member is (i) ramped from the first temperature to the second temperature, or (ii) changed step-wise from the first temperature to the second temperature.